BESIX

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BESIX Group is the largest Belgian construction group, a conglomerate of companies active in the construction, engineering, environmental, real estate and concession sectors.

In 1909, Jacques-Marie and Charles Stulemeijer see potential in prestigious construction projects in Belgium and set up the Société Belge des Bétons (SBB). They immediately earn their reward with the rebuilding of Belgian ports and canals, in the aftermath of the war and soon the activities expand in France and Spain.

In 1947 SBB recognizes the extraordinary market potential in former Belgian Congo and, together with the Belgian Group Empain, creates a common subsidiary Auxeltra-Béton.

Large projects in the Middle East demand a new organization from 1966. The six companies of the SBB Group form Six Construct. The success in this new region becomes considerable.

Since then, the group has known impressive and regular growth with the acquisition of new companies such as Entreprises Jacques Delens in Brussels, Etablissements Jean Wust in Wallonia and Vanhout in Flanders and, more recently, Van Britsom (Oostkamp), Verheye (Diksmuide), GRWestkust (Diksmuide) (50%), Socogetra (Awenne) and Cobelba (Naninne).

In the meantime, the company has entered the Egyptian and Libyan markets, it has also becomes an important player in France and the Netherland and has realized impressive projects in India, Russia, Poland, the Czech Republic, Slovakia, Algeria, Morocco and many other countries.

In 2004, thirteen managers of BESIX and its subsidiaries, together with Orascom Construction Industries, execute a management buy-out. SBB becomes BESIX Group, firmly anchored in Belgium.

Today, BESIX and its subsidiaries cover practically all fields of the construction industry and are operating in Western Europe, in Central and Eastern Europe, North and Central Africa, in the Middle East, in Central Asia and in the Caribbean. The Group realized a turnover of approximately 1.6 billion Euros and employs over 20.000 people worldwide.

The Group intends to be a leading international player, serving Western and Central European markets from its home country Belgium, and covering the Middle-East from the United Arab Emirates.

The success of the group is the result of:
- A commitment of upholding the highest standards of quality, reliability, professionalism and performance.
- The permanent seek of innovative ways to increase its expertise and enhance its performance.
- Providing a safe work environment
- A particular care for the teamwork spirit and the respect of individuals
- Taking new challenges that will strengthen the reputation and open new horizons.

Short Description

ZLOTA 44 - 200 m high tower in Warsaw

Besix was proud to be awarded the contract in 2007 for the design and build of the Zlota tower that will emerge from the very heart of Warsaw like a shining sculpture culminating at 192 m.
Designed by Daniel Libeskind for ORCO Property group, the tower accommodates 251 luxury apartments and sits on the side of a podium having 9 levels above ground and 2 below. The podium incorporates a retail area, an amenity floor, plant rooms and secured parking. Wrapped in curtain wall, the structure is essentially made of cast in situ reinforced concrete braced with a central concrete core stiffened with fin walls projecting up to the façade. It also includes a load transfer zone between the tower and the podium and is founded on a piled raft.
The building was entirely calculated with ESA-Prima Win using a general model counting 54000 nodes of which local models were extracted when necessary.

Project Information

Owner: ORCO Property Group
Architect: Architekt Daniel Libeskind Ag
General Contractor: Besix SA
Engineering Office: Besix Engineering Department
Construction Start: 15/01/2008
Construction End: 31/10/2010
Location: Warsaw, Poland

Projet general descrition and structural concept

Architecture

The Tower Zlota 44 will emerge from the very centre of Warsaw like a shining sculpture culminating at 192 m above ground. The building consists of an elegantly curved tower sitting eccentrically on top of a 54x36 m podium with two 67x51 m basement levels. Going from top to bottom, the project is organised as follows:
- 45 levels of residential apartments
- 1 level of amenities including a 25 m swimming pool, fitness centre, spa and hammam
- 1 level of mechanical equipment
- 6 levels above grade car park
- 1 ground floor level with a main lobby, retail space and a restaurant
- 2 basement levels dedicated to technical rooms and car park

Structural concept and particularities

The structure is essentially made of cast in situ reinforced concrete. A central concrete core stiffened with fin walls projecting up to the façade provides the horizontal bracing and is completed with internal and façade columns to give the vertical support to the slabs. The fin walls and perimeter columns follow the curves of the building in gently varying slopes.

The typical floor system consists of a 220 mm thick RC flat slab spanning 7 to 8.25 m in two ways between the walls and the columns. An 800 mm deep downstand beam runs around the perimeter of the building and is required for both structural and fire protection reasons.

At the interface between the tower and the podium, a transfer zone consisting of inclined columns and transfer beams is designed to accommodate the geometrical requirements dictated by each identity. The horizontal force component resulting from the inclined elements is tied back with Macalloy bars or cables that are post tensioned in phases as the construction progresses.

At the roof, steel structure is used to support the large parapet walls and the complex roof shapes.

The part of the building located under the tower is founded on a 2 m thick raft and barrettes acting together to transfer the load to the ground. Under the part of the podium adjacent to the tower, the building is founded on a 1.5 m thick raft without barrettes.

Used software: Scia Engineer, ESA-Prima Win

ZLOTA 44 - 200 m high tower in Warsaw

Numbers

- Height above ground: 192 m
- Total built up area: 71600 m²
- Mean area of one typical tower floor: 1200 m²
- Quantity of concrete (excluding piles): 34500 m³
- Quantity of steel reinforcement: 6950T
- Quantity of steel structure: 50T
- Completion time: 33 months (demolition of existing buildings not included)

Structural design

Model development

A complete 3D model of the tower including all slabs, beams, walls, columns, piles and the raft was made with ESA-Prima Win. The details of the model incorporates also all openings in the walls, lintels and slabs with the different type of concrete grades, and the bi-linear springs simulating the soil-structure interaction.

Due to the shape of the building, every single floor is different from one another. The construction of the model was made by creating a typical floor corresponding to the envelope of all levels. Then, by representing the façades with shell surfaces and using the intersection tool, the parts falling outside the shells were trimmed off.

The size of the general mesh is about 2 m which involves 54000 nodes and is sufficient to simulate the general behaviour of the structure. When detailing the calculating of one level, the mesh is locally refined over this level and the adjacent ones.

The graphical representation combined with the various members selection tools of the program where used to verify efficiently the geometry, the loads, the material characteristics of each element and the general behaviour of the model.

Particularities of the structural calculation

- Calculation of the foundation
  As mentioned earlier, the soil structure interaction is modelled with bilinear springs applied on the soffit of the raft, along the barrette shafts and on the barrette toes. The results obtained with this modelling were compared with those obtained from a 3D volumetric model and they appeared to be satisfactorily consistent.
- General building movement
  The foundation settlement and the difference of means compression stress between the core walls and the columns implied significant differential vertical displacement between the core of the tower and the perimeter. These movements are reduced, to some extent, by consideration of the construction phasing and creep
  To ensure that all situations are covered by the calculation, the slabs are calculated considering the envelope of the forces obtained from the general 3D model and from a partial model on fixed supports that can easily be extracted from the general one.
- Down load path and load transfer
  In the lower levels of the building, the architectural arrangement required complex load transfer that are also affected by the general building deformation. Graphical views of the principal stresses were used to better understand the down load path and find structural solutions.
- Calculation of the lintels:
  The lintels above the doors of the bracing walls are modelled as small wall elements including the details of all the openings. The reinforcement is calculated by using the possibility offered by the program to give the resultant forces in sections.
  In some cases the amount of openings required for the ducting is such that the lintels can not withstand the forces linking the parts of the bracing walls.
  In these cases, we included steel profiles in the concrete. These profiles could be better modelled with Scia Engineer that we started using during the project design. Therefore, we made local model of the lintels with this last program and applied the displacement obtained from the general model to calculate the profiles.

Conclusion

The different tools offered by the software contributed to achieve this very large and complex model swiftly, to control and operate it and to make the best use of the calculation results.